International Education Studies; Vol. 8, No. 1; 2015
ISSN 1913-9020 E-ISSN 1913-9039
Published by Canadian Center of Science and Education

The Relationship between Students' Perception of Being Safe in School, Principals' Perception of School Climate and Science Achievement in TIMSS 2007: A Comparison between Urban and Rural Public School

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Received: August 1, 2014 Accepted: October 9, 2014 Online Published: December 30, 2014

doi:10.5539/ies.v8n1p100 URL: http://dx.doi.org/10.5539/ies.v8n1p100

Abstract

This study concerns the assessment of the effects of Index of Principals' Perception of School Climate (PPSC), intimidation of students and gender in Moroccan public schools on student performance in science. The study focused on fourth grade students who participated in the TIMSS 2007. The objective of this study is to answer the following research questions: (1) Do schools make a difference in science achievement? (2) What is the effect of the index of principals' perception of school climate (PPSC) on student achievement? (3) What is the impact of intimidation by other students and gender on student achievement? What is the difference between urban and rural schools in science achievement? The results of the multilevel analysis show that the total variance situated at the school level is 24% in urban school, 50% in rural school and 42% in urban and rural together. Also, they affirm as the intimidation penalizes students' performances in sciences, the PPSC index is negatively correlated with the students' performances and the urban schools are favored compared to those in the rural areas.

Keywords: multilevel analysis, intimidation, PCM model, R software, school climate, TIMSS 2007

1. Introduction

The school climate is the subject of systematic studies since the fifties with a strong acceleration in recent years in many countries. The concept of school climate refers to the quality of life and perceived communication within school. We can consider school climate as the atmosphere in social relations, values, attitudes and shared feelings by the actors in the school. The school climate is a subjective variable related to the perception fostered by people on how they are treated and their roles in relation to others. There is no single definition of the school climate. Anderson (1982) has shown how it is difficult to define it. There is thus a frequent confusion between school climate and school safety. However, the literature shows that school climate emerges a multifactor definition wider than the one-dimensional of "school effect", which is however included. Also studies on the school climate can include the well-documented studies on "class effect" and "teacher effect" (Brault, 2004; Bressoux, 1994, 1995). Also, the sense of security is an integral part of school climate.

School climate has been considered by some authors as a part of school violence itself; this violence can take many forms such as: bullying, discrimination, homophobia, physical violence, sexual violence and indirect aggression. In any event, research shows that a positive school climate is a factor of resilience and well-being, and it has an important role in the prevention of violence. The latter is a serious problem that has many consequences, which affect students who are victims of violence tending to have low self-esteem and low social support which can lead to lack of motivation and lack of participation in school activities (Campart & Lindstrom, 1998). In addition, the school violence disrupts school life and degrades school climate (Blauvelt, 1999).

The variations in the school characteristics are associated with variations in student outcomes (Card & Krueger, 1996; Greenwald, Hedges, & Laine, 1996; Lockheed & Verspoor, 1991). Anthony and Yeow-Meng (1989), Croninger and Lee (2001), Meyer (1997) have proved that the academic performance of students depend on several factors such as school climate, school management, teacher satisfaction. Also the socioeconomic status, the student-teacher ratio and the heterogeneity of the class have influences on academic performance of students (Sanders & Horn, 1998). Other studies attempt to discover the relationship between student achievement and

teacher qualifications such as diplomas and teaching experience (Kane, Rockoff, & Staiger, 2008). Another study conducted by Parcel and Dufur (2001) showed that a good school climate has a positive effect on students' achievement in science. Parental involvement in school can strengthen the learning climate and has a positive impact on academic performance (Anderson, 1982; Corriveau & Brunet, 1993; Luke, 2001).

Milam, Furr-Holden and Leaf (2010) showed that students' performance is affected if they perceive their school as dangerous. The international surveys of student achievement in science are concerned with factors related to student performance in science on several levels: the individual characteristics of students and their family, teachers and schools and educational systems (Organisation for Economic Co-operation and Development, 2006). Coleman was the first researcher who has addressed the issue of school performance. Several empirical researches have been conducted responding to two fundamental questions (Coleman, 2007): Do the schools have measurable impacts on student performance? If yes, what are the sources of these impacts?

The objective of our study was to evaluate the impact of index of Principals' Perception of school climate, intimidation of students at school and gender of student on science achievement by using data from the Student Questionnaire and school Questionnaire from TIMSS 2007 (Trends International Mathematics and Science Study). On the one hand, this evaluation concerns urban and rural schools grouped in 158 schools and on the other hand, urban and rural schools in a separate way (79 in urban areas and 79 in rural areas). In this paper, we assume that all factors are controlled, and we will try to find answers to the following research questions:

(1) Do schools make a difference in science achievement?

(2) What is the difference between urban and rural schools in science achievement?

(3) What is the effect of the index of Principals' Perception of School Climate (PPSC) on student achievement in science?

(4) What is the impact of intimidation and gender on student achievement in science?

This paper is organized as follows:

Section 1: It provides an introduction addressing the context of study, its purpose and its research questions.

Section 2: It describes the methodology of study, it includes a brief overview of the TIMSS 2007, participants, a description of the dependent variables and explanatory variables, treatment of missing data, creation of the PPSC index, and finally merging school and student data files.

Section 3: It applies the multilevel analysis to answer the research questions.

Section 4: It discusses the results of modeling.

And finally, section 5 presents a conclusion of the study representing the main results of this research.

2. Method

To answer the first question, we used the One-way random effect ANOVA model; and for the second and the third question the *means as-outcomes model* and for the fourth question, we used the *Intercepts and Slopes as Outcomes Model* (Raudenbush & Bryk, 2002). Two statistical software were used in our application: the R software (R Core Team, 2012) and SPSS 20. The IEA (Note 1) IDB Analyzer Application 2009 was also used. The parameters of these models are estimated by the lme4 package (Bates, Maechler, Bolker, & Walker, 2013); the significance of fixed parameters (t-test) or random (LRT test) parameters was tested using the lmerTest package (Kuznetsova et al., 2013). The partial credit model (PCM) (Masters, 1982) was used to scale the PPSC index; the latter is represented by the ability parameter θ (see Creating and Interpreting the TIMSS and PIRLS 2011 Context Questionnaire Scales (Note 2)). The missing data are imputed by the MICE Method (Multivariate Imputation by Chained Equation) (van Buuren & Groothuis-Oudshoorn, 2011).

2.1 Participants

This study related to 158 public schools with 3 383 students (1 727 girls, 1 656 boys) of which: 79 urban schools with 1950 students (1 065 boys, 885 girls) and 79 rural schools with 1 433 students (662 boys, 771 girls). The two following files were used from TIMSS 2007 database (Note 3): Student and School background data files.

2.2 TIMSS 2007

Trends International Mathematics and Science Study (TIMSS) are conducted every four years and the most recent edition is that of 2011. TIMSS collects a wider range of background information on students' learning environments such as the teachers on the one hand fill out questionnaires on the teaching methods…On the other hand, surveyed school's principals provide information on the resources of the school and the climate of learning.

Students are also asked about their attitudes toward science and mathematics and school safety. The TIMSS used a stratified cluster sampling with two steps: the first step consists of sampling the schools by using "systematic probability-proportional-to-size (PS)" approach (Foy & Olson, 2009a) the second involves selecting a sample of whole classes of the targeted level in schools in the first sample; in Morocco one class by school was selected.

2.3. Measures and Covariates

2.3.1 Dependent Variable

The dependent variable was the mean score of student's achievement in Science from the five plausible values: ASSSCI01, ASSSCI02, ASSSCI03, ASSSCI04 and ASSSCI05 obtained by the methods of item response theory (Olson & Mullis, 2008).

2.3.2 Explanatory Variables

The explanatory variables are constituted by the index of Principals' Perception of the school climate noted by PPSC and five variables of the intimidation and gender of students (Foy & Olson, 2009b), these variables are aggregate on two levels:

Level 1 (student)

We find the students' gender (Note 4) and five variables of intimidation, which are based on responses to the following question in the Student Questionnaire:

In school, did any of these things happen during the last month?

(1) Something of mine was stolen (SQ1_12a, AS4GSTOL),

(2) I was hit or hurt by other student(s) (e.g., shoving, hitting, kicking) (SQ1_12b, AS4GHURT),

(3) I was made to do things that I didn't want to do by other students (SQ1_12c, AS4GMADE),

(4) I was made fun of or called names (SQ1_12d, AS4GMFUN),

(5) I was left out of activities by other students (SQ1_12e, AS4GLEFT),

Response options: Yes = 1; No = 2.

Level 2 (school)

There is a single variable which is the index of Principals' Perception of School Climate (PPSC) with Trends, this index is based on responses to the following question in the School Questionnaire.

How would you characterize each of the following within your school?

(1) Teachers' job satisfaction (SCQ1_8a, AC4GCHTS),

(2) Teachers' understanding of the school's curricular goals (SCQ1_8b, AC4GCHTU),

(3) Teachers' degree of success in implementing the school's curriculum (SCQ1_8c, AC4GCHTC),

(4) Teachers' expectations for student achievement (SCQ1_8d, AC4GCHES),

(5) Parental support for student achievement (SCQ1_8e, AC4GCHPS),

(6) Parental involvement in school activities (SCQ1_8f, AC4GCHPI),

(7) Students' regard for school property (SCQ1_8g, AC4GCHSR),

(8) Students' desire to do well in school (SCQ1_8h, AC4GCHSD),

Response options (Note 5): very high = 4; high = 3; medium = 2; low = 1; very low = 0.

2.4 Missing Data

In the presence of missing data, a solution is multiple imputations, which is a statistical method for the analysis of incomplete data originally proposed by Rubin (1987), and which can produce m matrix's imputed data. We used the method Multivariate Imputation by Chained Equation (MICE) (van Buuren & Groothuis-Oudshoorn, 2011). This procedure is implemented in R software with the mice package. Since the data is hierarchical, we chose to impute students' level variables (AS4GSTOL, AS4GHURT, AS4GMADE, AS4GMFUN, AS4GLEFT) and school level variables (AC4GCHTS, AC4GCHTU, AC4GCHTC AC4GCHES, AC4GCHPS, AC4GCHPI, AC4GCHSR AC4GCHSD) separately (m = 5). The data are categorical, for this we proposed to replace each missing value by the median value of 5 imputed values in each variable.

2.5 Descriptive and Reliability Analysis

We conducted descriptive statistics and the reliability analysis using SPSS 20 software.

Level 1 (student)

According to the form of intimidating behavior (Table 2), we notice that the girls are more intimidated than the boys in the urban or rural area, or in both areas grouped. Moreover, a chi-square (χ^2) test was conducted to examine this difference between girls and boys.

Thus, at the .05 level these differences are significant between boys and girls who have declared: (a) *"I was hit or hurt by other student(s)",* for both areas grouped, $\chi^2(1) = 10.01,\ p = .002$, for urban area, $\chi^2(1) = 6.82, p = .009$, and $\chi^2(1) = 4.520,\ p = .034$ for rural area; (b) *" I was made fun of or called names",* for both areas grouped, $\chi^2(1) = 16.51,\ p < .001$, for urban area, $\chi^2(1) = 11.49, p < .001$, and $\chi^2(1) = 4.85$, , $p = .025$ for rural area; (c) *"I was left out of activities by other students",* for both area grouped, $\chi^2(1) = 718.35,\ p < .001$, for urban area, $\chi^2(1) = 9.49, p < .002$, and $\chi^2(1) = 7.40,\ p = .006$, for rural area.

But the difference is not significant between the girls and the boys who declare: (d) *"I was made to do things that I didn't want to do by other students"*, for both areas grouped, $\chi^2(1) = 2.30,\ p = .129$, for urban area, $\chi^2(1) = 2.80, p = .094$, and $\chi^2(1) = .13,\ p = .0715$, for rural area.

However the difference is not significant between the two genders in both areas grouped, and significant in both separate areas together for those who declare: (e) *"Something of mine was stolen"*, for both areas grouped, $\chi^2(1) = .79, p = .0371$, for urban area, $\chi^2(1) = 28.10, p = .0488$, and $\chi^2(1) = .380,\ p = .0539$ for rural area.

Level 2 (school)

The item statistics of PPSC index and the item-total statistics are represented in Tables 3 and 5 respectively. The reliability analysis of these items show that all correlations inter-items are positive, the value of Cronbach's alpha equal to .82 and the corrected item-total correlation vary from .50 to .65. According to Pallant (2007), the items that have values lower than .3 will be eliminated from the analysis.

2.6 Scaling the PPSC Index

There are two models for ordinal items responses: the Rating Scale Model (RSM) (Andrich, 1978) and the Partial Credit Model (PCM) (Masters, 1982). Following the nature of the items in our application, we chose the one-dimensional PCM model. In this research, we use the adjustment *Infit* and *Outfit* indices used in the TAM package (Kiefer, Robitzsch, & Wu, 2014) of R software (R Core Team, 2012). The model parameters are estimated by *tam.mml* function (Test Analysis Modules: Marginal Maximum Likelihood Estimation). This function was used with the option *PCM2* (partial credit model with ConQuest parametrization "item + item * step"). The ability parameter θ (PPSC) is estimated by the *tam.wle* function (Weighted Likelihood Estimation). Items are perfectly adjusted from the model if the values of *Infit* and *Outfit* are equal to 1; some authors recommend an interval of critical values that extends from .5 to 1.7, which does not indicate a major problem of adjustment (Smith, Schumacker, & Bush, 1998; Linacre, 2010). Table 1 represents the adjustment of the observed responses of items indices *Infit* and *Outfit* and the corresponding t-values; we note that the values of these indices are between .83 and 1.16 and t-values are between -1.53 and 1.24. The reliability of the test (WLE (Note 6) Reliability = .85; EAP (Note 7) Reliability = .77) was good. These results show that the model adequately fits the items.

2.7 Merging School and Student Data Files

After the creation of the PPSC index, using the application IEA IDB Analyzer 2009 and SPSS software, we introduce the variable PPSC into the School background data files, and variables AS4GSTOL, AS4GHURT, AS4GMADE, AS4GMFUN and AS4GLEFT in the student background data files. Then, we put the two files in the same folder. Finally the application IEA IDB Analyzer was used for merging these variables (Note 8).

3. Methods of Analysis

Multilevel modeling is not always necessary for a database in a hierarchical structure. Zero ICC (Equation 4), indicates that there is no variation between group means. In this case, a single-level analysis is justified, instead of a multi-level analysis. But a non-zero value of ICC does not indicate that we can apply multi-level analysis. Particularly for social studies, a value of ICC between .05 and .20 is sufficient to apply HLM (Hox, 2002; Spybrook, Raudenbush, Liu, Congdon, & Martinez, 2008; Muthen, 1991; Muthen & Satorra, 1989, 1995). According to Muthen; Muthen & Satorra, if the value of Design effect denoted by DE (Equation 5) is greater than 2, we can apply the HLM. Therefore, the use of HLM depends on the coefficient of intra-class correlation

(ICC) and the Design Effect.

3.1 Do Schools Make a Difference in Science Achievement?

The first question is considered as one of the most fundamental research questions in the analysis of the school performance; it is the study of the variability of student performance between schools, and consequently whether it is necessary to use HLM to address other research questions. This question can be treated using a model known by the unconditional multilevel model or the empty model or one-way ANOVA model (Raudenbush & Bryk, 2002).

$$\text{Level 1 model}: \quad SciAch_{ij} = \beta_{0j} + \varepsilon_{ij};\ \varepsilon_{ij} \sim N(0, \sigma^2), \tag{1}$$

$$\text{Level 2 model}: \quad \beta_{0j} = \gamma_{00} + \mu_{0j};\ \mu_{0j} \sim N(0, \tau_{00}^2), \tag{2}$$

$$\text{Combined model } M_0: \ SciAch_{ij} = \gamma_{00} + \mu_{0j} + \varepsilon_{ij}, \tag{3}$$

$$\text{Intraclass correlation coefficient}: \ ICC = \tau_{00}^2/(\sigma^2 + \tau_{00}^2), \tag{4}$$

$$\text{Design Effect statistics}: \ DE = 1 + (n_c - 1)/ICC, \tag{5}$$

In this case, n_c: the number of students per school; $SciAch_{ij}$: science achievement score of student i nested in school j; γ_{00}: the grand-mean science achievement score of all schools; β_{0j}: the Science achievement mean for school j, σ^2 : within-school variance of $SciAch_{ij}$; τ_{00}^2: between-school variance.

3.2 What Is the Difference between Urban and Rural Schools in Science Achievement?

To study the difference between the two sectors, add the sector (urban, rural) variable to the empty model M0 (Equation 3):

$$\text{Level 1 model}: \quad SciAch_{ij} = \beta_{0j} + \varepsilon_{ij};\ \varepsilon_{ij} \sim N(0, \sigma^2), \tag{6}$$

$$\text{Level 2 model}: \quad \beta_{0j} = \gamma_{00} + \beta_{01}SECTOR + \mu_{0j};\ \mu_{0j} \sim N(0, \tau_{00}^2), \tag{7a}$$

$$\text{Level 2 model}: \quad \beta_{01} = \gamma_{10} \tag{7b}$$

$$\text{Combined model Ms}: \quad SciAch_{ij} = \gamma_{00} + \gamma_{10}SECTOR + \mu_{0j} + \varepsilon_{ij}, \tag{8}$$

3.3 What Is the Effect of the PPSC Index on Student Achievement?

For this research question, we used the *means as-outcomes model* (Raudenbush & Bryk, 2002):

$$\text{Level 1 model}: \ SciAch_{ij} = \beta_{0j} + \varepsilon_{ij};\ \varepsilon_{ij} \sim N(0, \sigma^2), \tag{9}$$

$$\text{Level 2 model}: \ \beta_{0j} = \gamma_{00} + \beta_{01}(PPSC_j - \overline{PPSC}) + \mu_{0j};\ \mu_{0j} \sim N(0, \tau_{00}^2) \tag{10a}$$

$$\text{Level 2 model}: \ \beta_{01} = \gamma_{10} \tag{10b}$$

$$\text{Combined model } M_1: \ SciAch_{ij} = \gamma_{00} + \gamma_{10}(PPSC_j - \overline{PPSC}) + \mu_{0j} + \varepsilon_{ij} \tag{11}$$

The term β_{0j} represents the Science achievement mean for school j; μ_{0j}: the random effect which measures the difference between the grand-mean γ_{00} and β_{0j} when $PPSC_j = \overline{PPSC}$; τ_{00}^2 measures the heterogeneity of β_{0j}; γ_{10}: fixed effect that represents the average slope of the schools.

3.4 What Is the Effect of Intimidation and Gender on Student Achievement?

For this research question we use the *Intercepts and Slopes as Outcomes Model* (Raudenbush & Bryk, 2002) as follows:

Level 1 model:

$$SciAch_{ij} = \beta_{0j} + \gamma_{01}AS4GSTOL + \gamma_{02}AS4GHURT + \gamma_{03}AS4GMADE + \gamma_{04}AS4GMFUN + \gamma_{05}AS4GLEFT + \gamma_{06}ITSEX + \varepsilon_{ij};\ \varepsilon_{ij} \sim N(0, \sigma^2), \tag{12}$$

$$\text{Level 2 model}: \ \beta_{0j} = \gamma_{00} + \beta_{01}(PPSC_j - \overline{PPSC}) + \mu_{0j};\ \mu_{0j} \sim N(0, \tau_{00}^2) \tag{13a}$$

$$\beta_{01} = \gamma_{10}, \tag{13b}$$

Combined model M_2:

$$SciAch_{ij} = \gamma_{00} + \gamma_{01}AS4GSTOL + \gamma_{02}AS4GHURT + \gamma_{03}AS4GMADE + \gamma_{04}AS4GMFUN + \gamma_{05}AS4GLEFT + \gamma_{06}ITSEX + \gamma_{10}(PPSC_j - \overline{PPSC}) + \mu_{0j} + \varepsilon_{ij} \tag{14}$$

3.5 Results

3.5.1 Schools Difference

There is a large variability in student performance between schools: in all schools ($\tau_{00}^2 = 4566$); urban school ($\tau_{00}^2 = 2120$) and rural school ($\tau_{00}^2 = 5739$). The proportion of variance explained at school level of science achievement is 42% for all schools, 24% for urban schools and 50% for rural schools. According to Raudenbush and Bryk (2002), Range of plausible values = $\hat{\gamma}_{00} \pm 1.96\sqrt{\hat{\tau}_{00}}$, that is 95% CIs [267.58,299.80], [297.79,324.39] and [238.14,272.26] respectively for all areas together, urban area then rural area. The estimated values of DE are greater than 2 for the three sample groups: DE = 49.88 for all urban and rural areas; DE = 100.90 for urban area and finally DE = 35.28 for rural area. So the use of HLM is necessary to explain the variability between schools (Muthen, 1991; Muthen & Satorra, 1989, 1995).

3.5.2 Difference between Urban and Rural Schools in Science Achievement

The results of Ms model (Tables 8 and 9), shows that the urban schools are favored by 55.92 points higher compared to rural schools, that is γ_{00} = 311.07, *SE*=7.15, *t*(142) = 43.49, *p* < .001, 95% CI [297, 325] for urban area and γ_{00} = 255.15, *SE* = 7.33, *t*(155) = 34.83, *p* < .001, 95% CI [241, 270] for rural areas. This difference is significant at the .001 level, γ_{10}(urban) - γ_{10}(rural) = 55.9, *SE* = 10.2, *t*(148) = 5.46, 95% CI [35.7, 76.2], *p* < .001.

3.5.3 Effect of the PPSC Index

Urban and rural schools together

The results of M_1 model (Equation 11) are represented in (Table 6, column 4). Thus, the PPSC index explains 2.52% of the total variance at school level, this index is negatively correlated with the students achievement and is significant at the .05 level, *t*(156) = -2.31, *p* = .022, *SE* = 3.77. Moreover, when the PPSC increases by one unit, the students' average score decreases by 8.70 units. Note that there is a large inter-school variability in group-mean ($\tau_{00}^2 = 4451$), moreover, τ_{00}^2 is significant at the .001 level, $\chi^2(1) = 1218,\ p < .001$.

Urban and rural schools separately

The estimate parameters from M_1 model (Equation 11) are shown in (Table 7, columns 3 and 6). The total variance explained (Note 9) by the PPSC index is 1.8% for rural area; this index is negatively correlated with the student's achievement and is not significant at the .05 level. When the PPSC increases by one unit, the students' average score decreases by 2.46 units for the urban school and by 8.31 units for the rural school. The inter-school variance τ_{00}^2 takes high values for the two types of schools. Its significant at the .05 level, $\chi^2(1) = 370$, $p < .001$ for the urban area and $\chi^2(1) = 638,\ p < .001$ for the rural area.

3.5.4 Effect of Intimidation and Gender

Urban and rural schools together

The results from the M_2 model (Equation 14) are shown in (Table 6, Column 4). 8.20% of the total variance at school level of science achievement is explained by the combination of the PPSC index, gender and the five variables of the intimidation: AS4GSTOL, AS4GHURT, AS4GMAD, AS4GMFUN and AS4GLEFT. On average, boys are favored by 3.88 points more than girls. However, the students intimidated by AS4GSTOL are favored over students who are not intimidated by 5.61 point higher. Moreover, students who are not intimidated favored over those intimidated by 10.06 points higher for AS4GHURT, *t*(3219) = 3.17, *p* = .0015, *SE* = 3.18; 27.75 points higher for AS4GMAD, *t*(3219) = 7.88, *p* <.001, *SE* = 3.50; 26.88 points higher for AS4GLEFT, *t*(3219) = 8.25, *p* <.001, *SE* = 3.26 and 2.80 points higher for AS4GMFUN.

Urban and rural schools separate

The estimated parameters from the M_2 model are shown in (Table 7, columns 4 and 7). The total variance explained at the school level by combining the PPSC index, gender and the five variables of intimidation is 7.52% for urban area and 6.90% in rural areas. At the .05 level, there are two significant differences in urban areas (AS4GMAD and AS4GLEFT) and three in rural areas (AS4GMAD, AS4GLEFT and AS4GHURT). The boys are favored over girls by 5.90 points for the urban schools and 2.38 points higher for rural schools.

On average, students who are intimidated by AS4GSTOL are favored over students who are not intimidated by 7.83 points higher for urban area and 1 point more for rural areas. However, in both areas, students who are not intimidated are favored over those that are intimidated by other forms of intimidation, for urban areas with the advantage of: 5.50 points for AS4GHURT; 32.09 points for AS4GMAD, *t*(1865) = 6.82, *p* <.001, *SE* = 4.70; 1.63 point for AS4GMFUN; 29.17 points for AS4GLEFT, *t*(1865) = 6.58, *p* <.001, *SE* = 4.34; in the same for the rural

environment with the advantage of 17.47 points for AS4GHURT, $t(1348) = 3.654$, p <.001, $SE = 4.78$; 21.97 points for AS4GMAD, $t(1348) = 4.162$, p <.001, $SE = 5.28$; 4.13 points for AS4GMFUN and 23.91 points for AS4GLEFT, $t(1348) = 5.026$, p <.001, $SE = 4.76$.

4. Discussion

4.1 Effect of the PPSC Index

In the case of urban and rural schools together, the results found in both M_1 and M_2 models (Table 6, columns 3 and 4) indicate that the PPSC index is negatively correlated with student performance and significant. However, the results of these two models for two areas separately (Table 7, columns 4 and 7) show that the effect of PPSC is not significant and negatively correlated with student performance. This index penalizes the student's performance in the rural areas more than the urban areas ($\gamma_{01} = -8.31$ versus $\gamma_{01} = -2.46$). Additionally, the average score of students in urban areas is higher than in rural areas ($M = 311.38$, $SE = 2.147$ versus $M = 255.51$, $SE = 2.70$). Note that the learning conditions are not the same for both areas, either at the socio-cultural, socio-economic or at the level of traditions. What can be applied in urban areas cannot be necessarily applied in rural areas. So the change in learning conditions can change student outcomes. This result is confirmed previously by Card and Krueger (1996); Greenwald, Hedges, and Laine (1996); Lockheed and Verspoor (1991), they showed that, the variations in school characteristics are associated with changes in student achievement.

4.2 Effect of Intimidation and Gender

After adding the variables of intimidation and gender to the M_1 model (Table 6, columns 4 and 7, Table 7, column 4), we note that the effect of PPCS (γ_{01}) changes slightly as: $\gamma_{01}(M_2)$-$\gamma_{01}(M_1)$=.26 for the two areas together, $\gamma_{01}(M_2)$-$\gamma_{01}(M_1)$=.14 for urban areas and $\gamma_{01}(M_2)$-$\gamma_{01}(M_1)$=.4 for the rural area. This shows that PPSC is one of the school effects that can significantly influence the learning environment for students and the results they get. The results found in this study indicate that the four forms of intimidation: AS4GMADE, AS4GMFUN, AS4GLEFT and AS4GHURT penalize the performance of students in science. A study conducted by Corriveau and Brunet (1993) show that the well-being of students promotes academic achievement. Cousin (1996) emphasizes the importance and usefulness of climate saying "this notion is interesting because it implies that the life of the school is likely to influence student achievement."

The urban area coefficients of AS4GMADE and AS4GLEFT are higher than those of the rural areas ($\gamma_{03} = 32.09$, $\gamma_{05} = 29.17$ versus $\gamma_{03} = 21.97$, $\gamma_{05} = 23.9$), indicating that these two forms of intimidation penalize the students of urban environment more than those of rural environment. Moreover, the coefficients of AS4GHURT and AS4GMFUN of rural area are higher than that of urban environment ($\gamma_{02} = 17.47$, $\gamma_{04} = 4.13$ versus $\gamma_{02} = 5.5$, $\gamma_{04} = 1.63$), so these two forms of intimidation act more on the students of the rural area than those of urban area.

The relationship between academic achievement and the gender of the student was addressed in most studies which tend to search the explanatory factors of success or failure at school (Bastin & Roosen, 1990).The results of the descriptive statistics (Table 2) show that girls are more intimidated than boys, also the extra results in (Table 6, columns 4 and 7, Table 7, column 4) show that on average the boys exceed the girls within two separate areas and for both areas grouped. Thus, the intimidation affects the performances of girls more than boys.

5. Conclusion

This study examines the effect of intimidation of students at school, the index of Principals' Perception of School Climate (PPSC) and the gender on students' achievement in science. The results reveal that the total variance in student performance explained at school level is 24% for urban area, 50% in rural area and 42% for the two areas together, the total variance explained by the combination of the PPSC index, the five variables of intimidation and students' gender is 7.52% in urban area, 6.90% in rural area and 8.20% in the two environments together.

The research findings show that the PPSC index is negatively correlated with the students' performances in sciences; the urban schools are favored compared to rural schools; the girls are more intimidated than the boys. Finally, the four forms of intimidation AS4GHURT, AS4GMAD, AS4GMFUN and AS4GLEFT affect the students' achievement in science.

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Notes

Note 1. International Association for the Evaluation of Educational Achievement.

Note 2. http://timssandpirls.bc.edu/methods/pdf/TP11_Context_Q_Scales.pdf.

Note 3. The database is available from: http://timssandpirls.bc.edu/TIMSS2007/idb_ug.html.

Note 4. The students' gender is encoded by: Girl=1; boy=2.

Note 5. Response options are reversed.

Note 6. Weighted likelihood estimation.

Note 7. Expected a posteriori estimation.

Note 8. See the second chapter of Foy & Olson (2009a): Using the IEA IDB Analyzer to Analyze the TIMSS 2007 International Database.

Note 9. The value of R^2 is negative for urba schools.

Appendix

Table 1. The adjustment of the observed responses of items indices *Infit* and *Outfit*

Item	Outfit	Outfit_t	Infit	Infit_t
AC4GCHTS	.93	-.66	.94	.56
AC4GCHTU	.91	-.88	.91	-.86
AC4GCHTC	1.01	.17	1.04	.41
AC4GCHES	1.01	.14	1.03	.32
AC4GCHPS	0.84	-1.53	.83	-1.71
AC4GCHPI	1.03	.33	1.03	.34
AC4GCHSR	1.13	1.14	1.13	1.24
AC4GCHSD	.87	-1.30	.87	-1.28
WLE Reliability =.85				
Variance = 2.07				
EAP Reliability =.77				

Table 2. The proportion of the students who undergo certain intimidating forms at school and chi-square test

	Urban and rural together		Urban		Rural	
Something of mine was stolen (AS4GSTOL)						
	Yes (30.90%)	No (69.10%)	Yes (31.2%)	No (68.8%)	Yes (30.6%)	No (69.4%)
Boy	30.20%	69.80%	30.5%	69.5%	29.8%	70.2%
Girl	31.6%	68.40%	32.00%	68.0%	31.3%	68.7%
	$\chi^2 = .79,\ df = 1,\ p = .0371$		$\chi^2 = 28.1,\ df = 1,\ p = .488$		$\chi^2 = .380,\ df = 1,\ p = .539$	
I was hit or hurt by other student(s) (e.g., shoving, hitting, kicking) (AS4GHURT)						
	Yes (29.7%)	No (70.3%)	Yes (31.2%)	No (68.8%)	Yes (27.6%)	No (72.4%)
Boy	27.3%	72.2%	28.7%	71.3%	24.9%	75.10%
Girl	32.2%	67.8%	34.2%	65.8%	30.0%	70.0%
	$\chi^2 = 10.01,\ df = 1,\ p = .002$		$\chi^2 = 6.82,\ df = 1,\ p = .009$		$\chi^2 = 4.520,\ df = 1,\ p = .034$	
I was made to do things that I didn't want to do by other students (AS4GMADE)						
	Yes (21.30)%	No (78.70%)	Yes (21.1%)	No (78.9%)	Yes (21.4%)	No (78.6%)
Boy	20.20%	79.80%	19.7%	80.3%	21.0%	79.0%
Girl	22.3%	77.7%	22.8%	77.2%	21.8%	78.2%
	$\chi^2 = 2.30,\ df = 1,\ p = .129$		$\chi^2 = 2.80,\ df = 1,\ p = .094$		$\chi^2 = .13,\ df = 1,\ p = .0715$	
I was made fun of or called names (AS4GMFUN)						
	Yes (30.0%)	No (70.0%)	Yes (29.4%)	No (70.6%)	Yes (30.80%)	No (69.20%)
Boy	26.9%	73.10%	26.2%	66.8%	27.90%	72.10%
Girl	33.30%	66.70%	33.2%	70.6%	33.3%	66.70%
	$\chi^2 = 16.51,\ df = 1,\ p < .001$		$\chi^2 = 11.49,\ df = 1,\ p = .001$		$\chi^2 = 4.85,\ df = 1,\ p = .025$	
I was left out of activities by other students (AS4GLEFT)						
	Yes (28.10%)	No (71.90%)	Yes (26.6%)	No (73.4%)	Yes (30.10%)	No (69.9%)
Boy	24.80%	75.20%	23.8%	76.2%	26.60%	73.40%

Girl	31.50%	68.50%	29.9%	70.1%	33.20%	68.80%
	$\chi^2 = 718.35,\ df = 1,\ p < .001$		$\chi^2 = 9.49,\ df = 1,\ p = .002$		$\chi^2 = 7.40,\ df = 1,\ p = .006$	

Source data: TIMSS 2007 database.

Table 3. Item Statistics.

Item	*M*	*SD*	N
AC4GCHTS	2.41	.69	158
AC4GCHTU	2.31	.67	158
AC4GCHTC	2.33	.66	158
AC4GCHES	2.35	.67	158
AC4GCHPS	3.68	.85	158
AC4GCHPI	3.78	.83	158
AC4GCHSR	2.9	1.09	158
AC4GCHSD	2.65	.70	158

Source data: TIMSS 2007 database.

Table 4. Inter-item correlation matrix (Cronbach's Alpha =.82)

	AC4GCHTS	AC4GCHTU	AC4GCHTC	AC4GCHES	AC4GCHPS	AC4GCHPI	AC4GCHSR	AC4GCHSD
AC4GCHTS	1	.52	.45	.29	.39	.29	.43	.31
AC4GCHTU	.52	1	.65	.47	.34	.24	.32	.29
AC4GCHTC	.45	.65	1	.45	.32	.22	.23	.21
AC4GCHES	.29	.47	.45	1	.43	.29	.28	.32
AC4GCHPS	.39	.34	.32	.43	1	.63	.40	.52
AC4GCHPI	.29	.24	.22	.29	.63	1	.37	.44
AC4GCHSR	.43	.32	.23	.28	.40	.37	1	.50
AC4GCHSD	.31	.29	.21	.32	.52	.44	.50	1

Source data: TIMSS 2007 database.

Table 5. Item-total statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
AC4GCHTS	20.06	13.95	.56	.38	.80
AC4GCHTU	20.16	13.98	.57	.52	.80
AC4GCHTC	20.14	14.35	.50	.46	.81
AC4GCHES	20.12	14.25	.51	.34	.80
AC4GCHPS	18.78	12.67	.65	.53	.78
AC4GCHPI	18.69	13.39	.53	.42	.80
AC4GCHSR	19.51	12.10	.53	.35	.81
AC4GCHSD	19.82	13.88	.56	.38	.80

Source data: TIMSS 2007 database.

Table 6. Parameter estimates for alternative multilevel science achievement models: urban and rural schools together

Parameter	M0	M1	M2
Fixed effects			
Intercept (γ_{00})	283.69 (5.59)**	284.57 (5.54)***	236.18 (7.18)***
PPSC (γ_{10})		-8.70 (3.77)*	-8.46 (3.66) *
AS4GSTOL (γ_{01})$^{(r)}$			-5.61 (3.18)
AS4GHURT (γ_{02})$^{(r)}$			10.06 (3.18)**
AS4GMADE (γ_{03})$^{(r)}$			27.75 (3.52)***
AS4GMFUN (γ_{04})$^{(r)}$			2.8 (3.19)
AS4GLEFT (γ_{05})$^{(r)}$			26.88 (3.26)***
ITSEX (γ_{06})$^{(s)}$			3.94 (2.81)
Variance components			
Within school (Level 1) (σ^2)	6369	6368	6054
Between school (Level 2)			
Intercept (τ_{00}^2)	4566$^{(a)}$	4451.3$^{(b)}$	4192$^{(c)}$
R^2 (intercept)		2.52%	8.20%
ICC	42%		
DE	49.88		

Note: * $p < .05$; ** $p < .01$; *** $p < .001$; $^{(r)}$ Reference category (Yes=1); Reference category (girl=1); The numbers in () represent the standard error; $^{(a)}$ $\chi^2(1) = 1218,\ p < .001$; $^{(b)}$ $\chi^2(1) = 1213,\ p < .001$; $^{(c)}$ $\chi^2(1) = 1169,\ p < .001$.

Table 7. Parameter estimates for alternative multilevel science achievement models: urban and rural schools separately

	Urban schools			Rural schools		
Parameter	M0	M1	M2	M0	M1	M2
			Fixed effects			
Intercept (γ_{00})	311.09 (5.52)*	310.73 (5.57)*	261.83 (8.20)*	255.20 (8.84)*	258.20 (9.03)*	207.86 (11.47)*
PPSC (γ_{10})		-2.46 (4.14)	-2.32 (3.98)		-8.31 (5.70)	-7.95 (5.54)
AS4GSTOL (γ_{01})$^{(r)}$			-7.83 (4.27)			-1.0 (4.71)
AS4GHURT (γ_{02})$^{(r)}$			5.5 (4.24)			17.47 (4.78)*
AS4GMADE (γ_{03})$^{(r)}$			32.09 (4.70)*			21.97 (5.28)*
AS4GMFUN (γ_{04})$^{(r)}$			1.63 (4.34)			4.13 (4.68)
AS4GLEFT (γ_{05})$^{(r)}$			29.17 (4.43)*			23.91 (4.76)*
ITSEX (γ_{06})$^{(s)}$			5.90 (3.85)			2.38 (4.07)
			Variance components			

Within school (Level 1) Residual (σ^2)	6819	6819	6444	5737	5736	5493
Between school (Level2)						
Intercept (τ_{00}^2)	2120[a]	2139[b]	1978[c]	5739[d]	5671[e]	5343[f]
R^2 (intercept)		-	7.52%		1.18%	6.90%
ICC	24%			50%		
DE	100.90			35.28		

Note: * $p < .001$; [r] Reference category (Yes=1); [s] Reference category (girl=1); The numbers in () represent the standard error.; [r] Reference category (Yes=1); Reference category (girl=1); [a] $\chi^2(1) = 371,\ p < .001$; [b] $\chi^2(1) = 370,\ p < .001$; [c] $\chi^2(1) = 357,\ p < .001$; [d] $\chi^2(1) = 635,\ p < .001$; [e] $\chi^2(1) = 638,\ p < .001$; [f] $\chi^2(1) = 357,\ p < .001$.

Table 8. Parameter estimates for alternative multilevel science achievement models: M0 and Ms models.

Parameter	M0	Ms
Fixed effects		
Intercept (γ_{00})	283.69 (5.59)*	311.06 (7.15)*
SECTEUR (γ_{10})[r]		-55.92 (10.24)*
Variance components		
Within school (Level 1) (σ^2)	6369	6372
Between school (Level 2)		
Intercept (τ_{00}^2)	4566[a]	3771[b]
R^2 (intercept)		17.41%
ICC	42%	

Note: * $p < .001$; [r] Reference category (Urban school=1); The numbers in () represent the standard error.; [a] $\chi^2(1) = 371,\ p < .001$; [b] $\chi^2(1) = 989,\ p < .001$.

Table 9. Least squares means and least squares means differences for Ms models.

Variable	Estimate	*SE*	*df*	*t*	95% CI	*p*
Least squares means						
SECTEUR 1	311.07	7.15	142	43.49	[297, 325]	<.001
SECTEUR 2	255.15	7.33	155	34.83	[241, 270]	<.001
Differences of LSMEANS[a]						
SECTEUR 1- SECTEUR 2	55.9	10.2	148.3	5.46	[35.7, 76.2]	<.001

Note: [a] Least squares means differences; CI = confidence interval.